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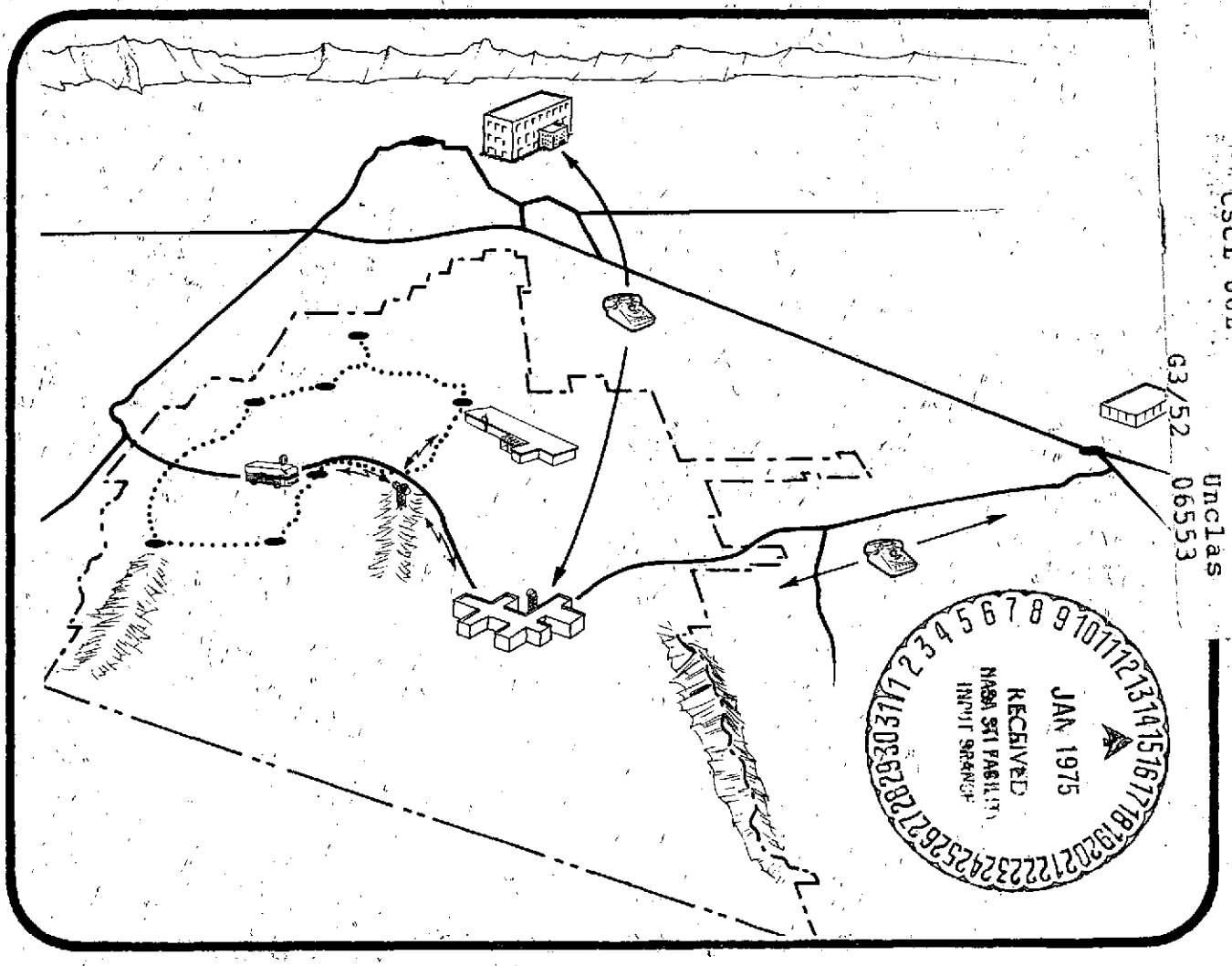
STARPAHC

PART 1 FINAL SUMMARY REPORT



LOCKHEED MISSILES & SPACE COMPANY, INC.

LMSC-A334458
JUNE 1974

STARPAHC

PART 1 FINAL SUMMARY REPORT

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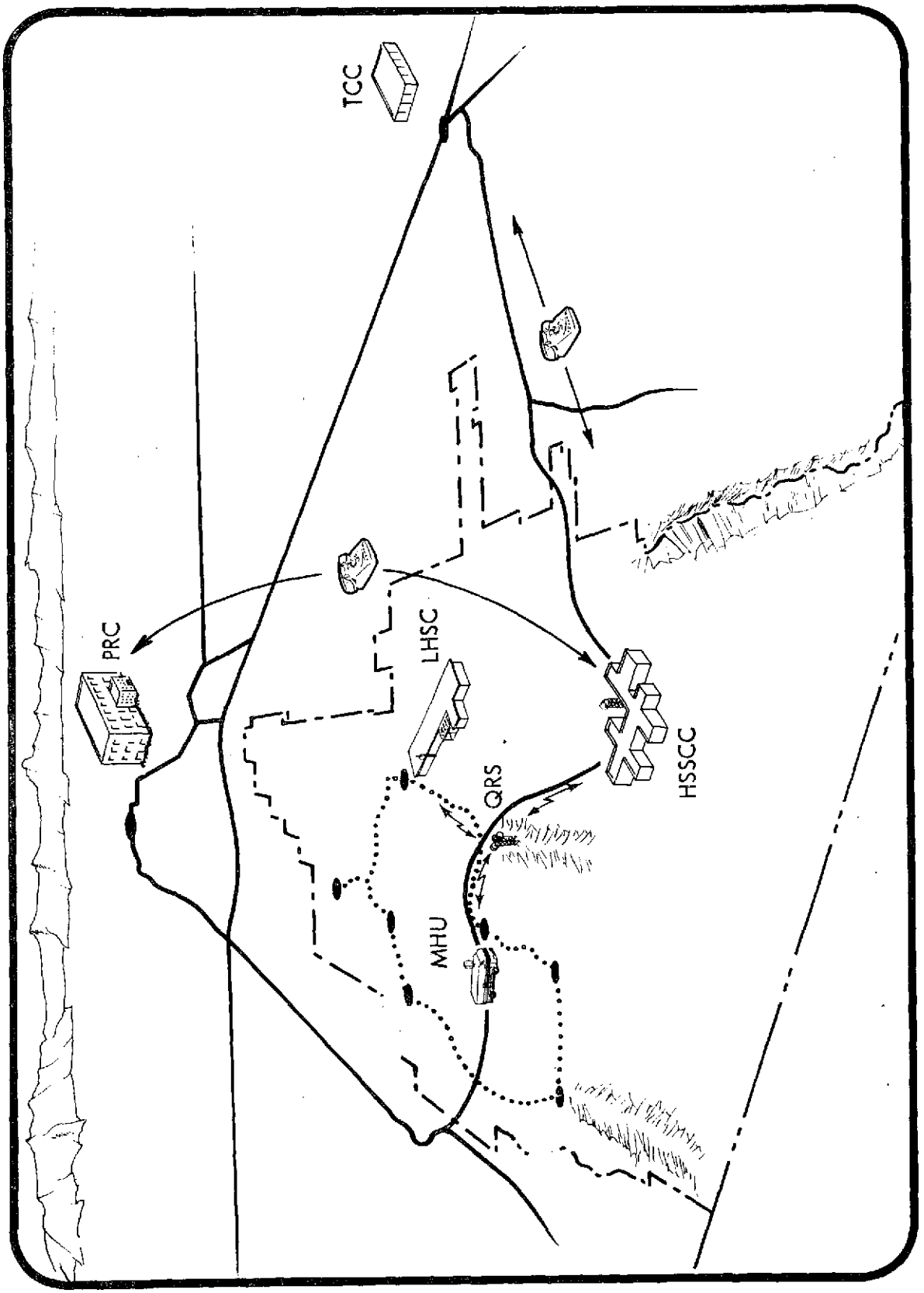

TCC
PRC
LHSC
HSSCC
QRS
MHU

FOREWORD

Lockheed Missiles & Space Company, Inc. (LMSC), submits this Part 1 Final Summary Report in compliance with the requirements of Contract NAS 9-13170 dated 15 December 1972.

This report summarizes the accomplishments achieved on the STARPAHC Program during Part 1 (Design and Definition), the continued progress during Part 2 (System Assembly, Test, Installation, Checkout, and Training), and plans for Part 3 (Operations and Evaluation).

ACKNOWLEDGMENTS

This report summarizes Contract NAS9-13170, Part 1, Technical Achievements, as accomplished by the STARPAHC Design Team and supporting subcontractors. The STARPAHC program is being conducted under the direction of the NASA/JSC Contract Monitor, Norman Belasco. The LMSC STARPAHC Contractor design team was under the direction of James M. Smith, Program Manager, assisted by F. E. Riley. The LMSC Design Team was guided and supported by NASA technical managers and by IHS personnel. Appendix A lists the participants and their areas of responsibilities and expertise.

CONTENTS

ILLUSTRATIONS

GLOSSARY OF ABBREVIATIONS

ac	Alternating Current
A-D	Analog to Digital
A/N CRT	Alpha/Numeric Cathode Ray Tube
B&W	Black and White
baud	Unit of Signaling Speed
BIA	Bureau of Indian Affairs
CDR	Critical Design Review
CHR	Community Health Representative
CHM	Community Health Medic
CRT	Cathode Ray Tube
D-A	Digital to Analog
dc	Direct Current
DHEW	Department of Health, Education, and Welfare
ECG	Electrocardiogram
FCC	Federal Communications Commission
FD or FDX	Full Duplex
FOD	Flight Operations Division – NASA/JSC
FTS	Federal Telecommunications System
GFE	Government Furnished Equipment
GHz	Gigahertz (billion cycles per second)
HIS	Health Information System
HRA	Health Resources Administration
HSA	Health Services Administration
HSSCC	Health Services Support Control Center
Hz	Hertz (cycles per second)
IHS	Indian Health Service
IMBLMS	Integrated Medical and Behavioral Laboratory Measurement System
IPO	IMBLMS Program Office
JSC	Johnson Space Center
KFI	Kaiser Foundation International
LAC	Lockheed Aircraft Corporation

LHSC	Local Health Services Center
LMSC	Lockheed Missiles & Space Co., Inc.
LVN	Licensed Vocational Nurse
MHU	Mobile Health Unit
MHW	Mental Health Worker
MHz	Megahertz (million cycles per second)
NASA	National Aeronautics and Space Administration
NASA-MEDICS	NASA Medical Information Computer System
NBS	National Bureau of Standards
NTSC	National Television Standards Committee
OMIS	Office of Management Information Systems
PA	Physician's Assistant
PAM	Portable Ambulance Module (Telecare unit manufactured by SCI Electronics, Houston, Texas)
PHN	Public Health Nurse
PHS	Public Health Service
PIMC	Phoenix Indian Medical Center
PRC	Phoenix Referral Center (STARPAHC terminal equipment located in Phoenix Indian Medical Center)
QA	Quality Assurance
QRS	Quijotoa Relay Station
R&DD	Research and Development Division (of LMSC)
rf	Radio Frequency
S/C	Subcontractor
SCN	Specification Change Notice
shf	Super-High Frequency (STARPAHC 7.5-GHz Band)
S/N	Signal-to-Noise Ratio
STARPAHC	Space Technology Applied to Rural Papago Advanced Health Care
TCC	Tucson Computer Center
TTY	Teletypewriter
uhf	Ultra-High Frequency (STARPAHC 1.8-GHz Band)
USPHS	United States Public Health Service
VDM	Varian Data Machine
vhf	Very-High Frequency (STARPAHC 170-MHz Band)

Section A
INTRODUCTION

The Integrated Medical and Behavioral Laboratory Measurement System (IMBLMS)/ Space Technology Applied to Rural Papago Advanced Health Care (STARPAHC) Program covers a 4-year program for the NASA (Johnson Space Center) working in conjunction with DHEW (IHS) for the purpose of conducting a ground-based demonstration of IMBLMS Space Technology in a remote geographical area of the U.S. The two primary program objectives are: (1) to obtain data for application to future spacecraft design and (2) to improve health care delivery through application of space technology. STARPAHC is designed to improve the capability for delivering health care to the Papago Indians located on the Papago Indian Reservation in southwest Arizona.

The scope of work includes all activities, equipment, and facilities necessary for accomplishing the three basic parts specific to STARPAHC:

- Part 1 – Definition and Design
- Part 2 – System Assembly, Test, Installation, Checkout, and Training
- Part 3 – Operation and Evaluation of the System at a Remote Site

The period of performance for completion of this work is 48 months. The milestones for specific program elements are contained in the Overall Program Schedule (Fig. 1).

STARPAHC includes one of each of the following elements:

- Sells Hospital (Health Services Support Control Center – HSSCC)
- Santa Rosa Health Center (Local Health Services Center – LHSC)
- Mobile Health Unit (MHU)
- Phoenix Referral Center (PRC) in the Phoenix Indian Medical Center
- Tucson Computer Center (interface only)
- Relay Station (Quijotoa Mountain Range)

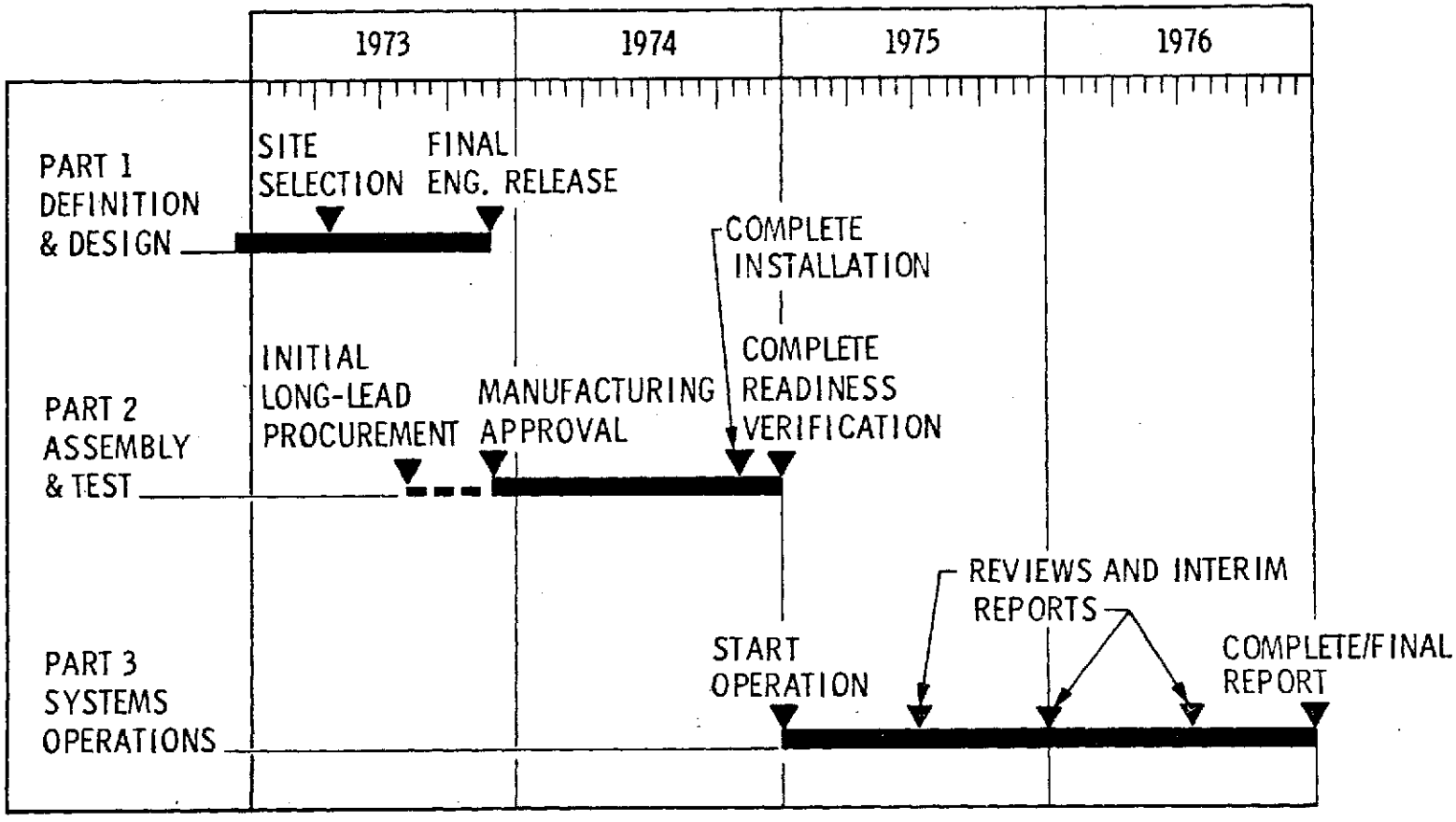


Fig. 1 Overall Program Schedule

The STARPAHC operational concept is based on utilizing the professional staff of the Sells Hospital, where the HSSCC will be located, to provide direction and consultation to paramedical and technical personnel stationed at the remote clinics, LHSC, and the MHU. The interchange of information between the HSSCC, LHSC, and MHU will be accomplished by voice, data, and video communication links. Computer-based data management techniques will implement record keeping, data retrieval, and data analysis.

These elements will be operated by a team consisting of IHS-provided physicians and health-care professionals and by LMSC-provided technical personnel. Remote health-care professionals will be under the direct supervision of an IHS physician at Sells by means of voice, data, and video communication channels between the STARPAHC elements interconnected by the relay station on Quijotoa (as depicted on Fig. 2).

Special interfaces in terms of medical referral and/or consultation exist between the Sells Hospital and the Phoenix Indian Medical Center. These interfaces are supported by voice, data, and Slo-Scan TV transmission via telephone lines between the HSSCC and PRC.

The HSCC will provide space for a vhf radio controller to enable communications with the existing IHS ambulance radio frequency. An area and interface capability is also provided at the HSSCC for a base station for communication with a Portable Ambulance Module (PAM) installed in an IHS Ambulance Van.

Interface between the HSSCC and the Tucson Computer Center will be by high-speed serial-digital signals via conditioned telephone lines.

The organizational relationships within and among participating elements involved in the Operations Phase of the STARPAHC Program are depicted in Fig. 3. Major responsibilities for the STARPAHC Program are delineated in Table 1.

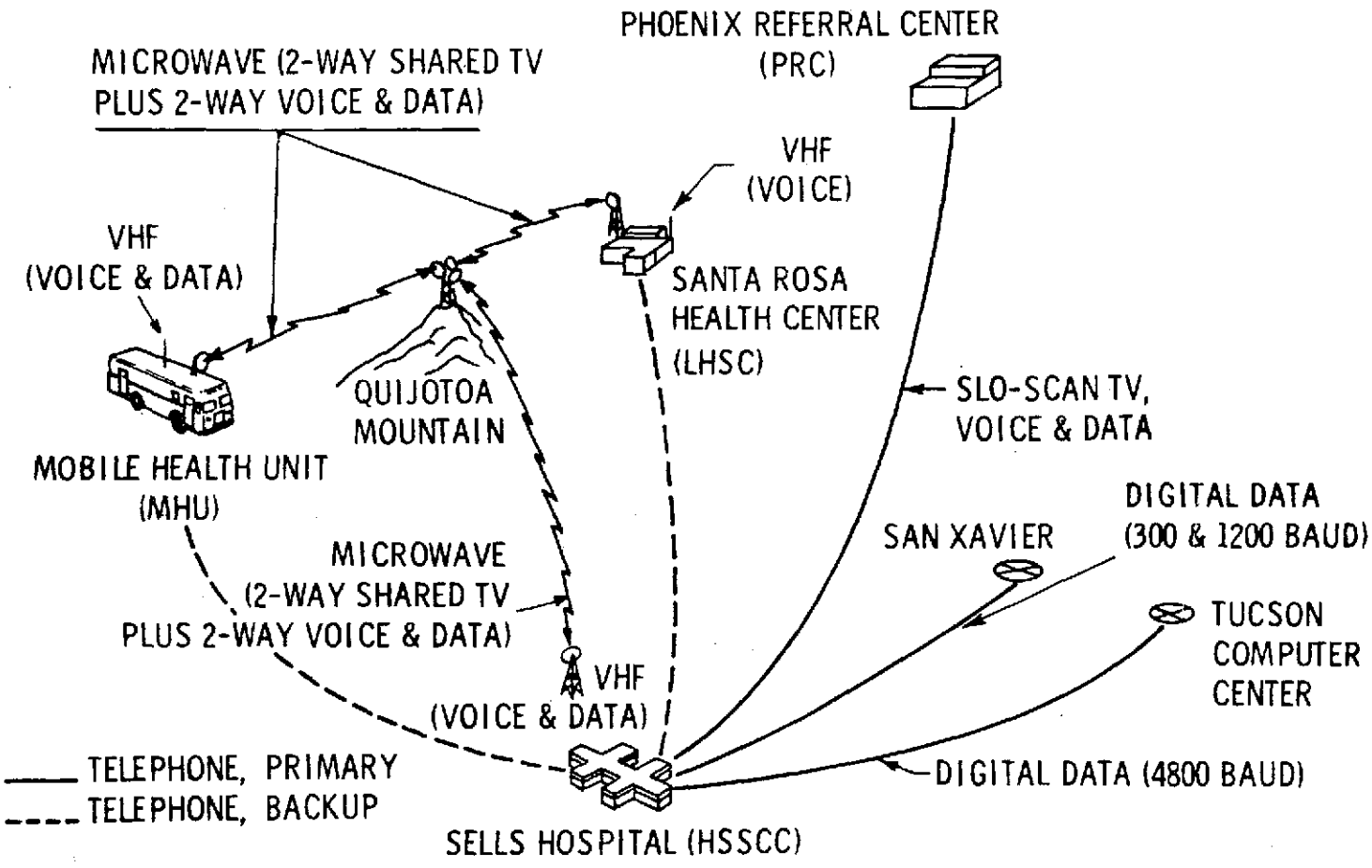


Fig. 2 System Configuration

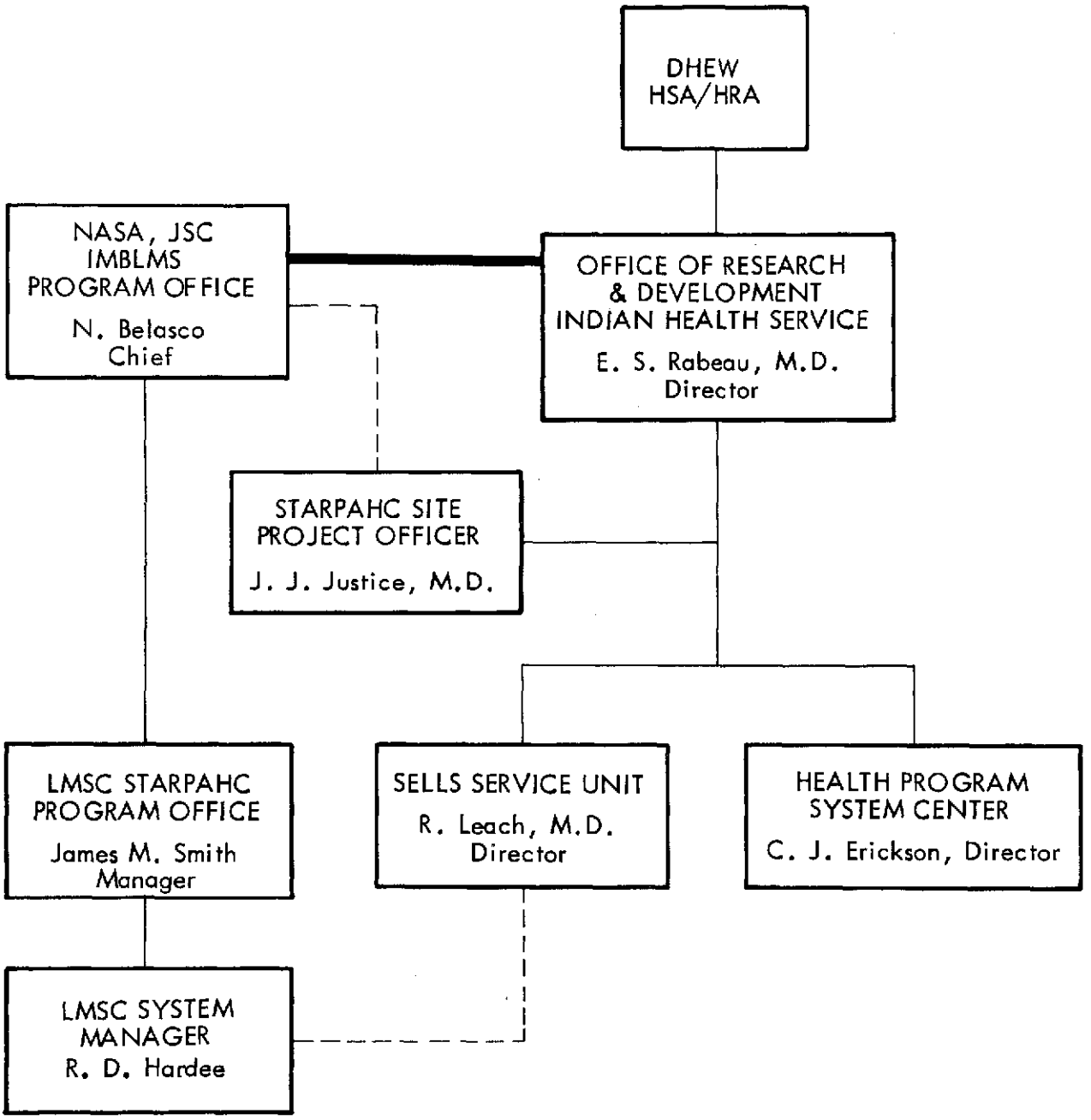


Fig. 3 Organization Relationships – STARPAHC Operations

Table 1

MAJOR RESPONSIBILITIES FOR IMBLMS/STARPAHC

NASA IMBLMS Program Office	DHEW IHS/Office of R&D	LMSC Biotechnology
Program Management • Program Planning and Budgeting • Technical Direction and Control • Interagency and Contractor Coordination • Program Data and Documentation Control • Government-Furnished Equipment (GFE)	Program Management Team Member • Program and Contractor Guidance and Coordination • GFE, Facilities, Personnel, and Services • Data Base • Medical Operations Management • Interface with Papago Executive Health Staff and Indian Community • Medical evaluation	Prime Contractor • System Definition and Design Responsibility • System Assembly, Test, Installation, Checkout, and Training • Field System Operations and Maintenance; System Evaluation • Computer/Software Interfaces

Section B
SUMMARY

This report summarizes the accomplishments achieved from program startup, Part 1 (Definition and Design), through initiation of Part 2 (Assembly). It highlights how the system requirements were met in the areas of communication, specialized medical equipment, display, and computer software.

Budgetary history of Part 1 (planned versus actual costs) is discussed. The redirection and reduction from the original value of the Program ($4,942,079) to $3,352,000 are traced and the involvement and support from IHS delineated.

Part 2 planned activities are summarized, and a brief description of each major task is given. The cost plans for Parts 2 and 3 are presented, and a fiscal year funding profile is provided.

Potential problem areas of procurement, subcontractor support, and test are discussed, and remedial actions that are used to ensure success in schedule and budget are described.

Part 3 (Operations and Evaluation) concludes the report and discusses the operational division of responsibility between IHS (Medical) and LMSC (System). A brief discussion of activities that precede the operational phase (Installation and Checkout, and Site Acceptance Test) is presented. A description of the form of medical support by IHS and system support by LMSC concludes this section.

The Appendix A includes a list of the program participants and Appendix B lists documentation and engineering drawing sources regarding STARPAHC.

Section C
PART 1 ACCOMPLISHMENTS

Part 1 program accomplishments are identified in two general areas – technical and budgetary history.

C.1 TECHNICAL ACCOMPLISHMENTS

Part 1 technical accomplishments are primarily concerned with developing and evolving a system concept that has general design applicability to various potential sites (for eventual export), and a detail design custom-fitted to meet the constraints, capabilities, and requirements unique to the selected Papago Indian Reservation site.

C.1.1 General Accomplishments

The general engineering accomplishments are as follows:

- Furnished technical support and assistance in the analysis and comparisons of three candidate sites for site selection.
- Developed a system concept for the Papago Indian Reservation site.
- Established functional, operational, design, and interface requirements.
- Prepared CEI specifications for each STARPAHC major element including software.
- Furnished detail development plans covering all aspects of Program Management, Engineering, Manufacturing, Quality Assurance, and Test.
- Developed an Operation Support Plan which defines the major activities needed to provide operation support with respect to installation and checkout, logistics, maintenance, calibration and repair, personnel selection and training, and operations.
- Completed the system design and documentation.

C.1.2 Specific Accomplishments

The specific technical accomplishments relate to system hardware and software to accomplish the system functions. They concern the selection of communication systems, specialized medical equipment, display and control approaches, and computer system equipment and techniques. The following highlights are presented:

- Communication
  - Dual-feed antennas permitting utilization of a single 4- or 6-ft dish for two different frequency elements
  - Improved Slo-Scan equipment for transmission of visual images from Sells Hospital to the Phoenix Indian Medical Center via telephone lines
  - Circuitry/logic to permit a data system to communicate with a remote data terminal over a half-duplex vhf radio link
  - Circuitry/logic to enable fire, break-in, and emergency handset sensors to activate a vhf radio link during off-duty hours
- Specialized Medical Equipment
  - TV/microscopy for transmission of microscopic slide data
  - Application of a fiber optics type surgical viewing microscope for endoscopic-type examination and TV transmission of the area examined
  - Utilization of an electronic stethoscope for transmitting heart and lung sounds
  - Provision of a Mobile Health Unit with similar capability to that of a fixed clinic – x-ray, laboratory, and examination plus microwave and vhf communication
- Display and Control
  - AN/CRT display for physician
  - CRT display to Community Health Medics (CHMs) of patient medical data
  - Privacy control for physician
  - Physician and/or patient image display at each location
  - Remote camera control capability for physician
  - Overhead track and swivel boom mount for TV camera

- Computer/Software
  - Core memory of 64k words expandable to 256k words
  - Omni task real-time executive allows computer to act as data concentrator and separate minicomputer
  - Five specialized software application programs
  - Integration of MEDICS II Program

C.1.3 Site Analysis and Selection

Part 1 (Definition and Design) was concerned initially with a detailed comparison of three final candidate sites and (once the Papago Indian Reservation was selected by DHEW) a series of detailed design activities to select techniques and equipment tailored to the specific site needs.

LMSC provided technical support and assistance to a combined NASA/DHEW team during the site analysis. LMSC prepared a Site Analysis Report (SAR), LMSC-D333570, 25 January 1973, including site data, system options, cost comparisons, summary analysis, and other pertinent data. The SAR was presented to the NASA/DHEW Site Selection Working Group for use in developing candidate site findings. The 15 applicants were initially screened to three candidates who were then subjected to a more critical analysis, based on criteria considered of utmost importance to the successful operation of the STARPAHC Program.

The three candidates were:

- Las Cruces, New Mexico
- Papago Indian Reservation, Arizona
- Williamsport, Pennsylvania

These three areas were visited by representatives of NASA, DHEW, and LMSC to further examine the desirability of these sites for the STARPAHC system.

After careful analysis of the available material, site visits, and accumulation of site data, the Office of the Undersecretary, DHEW, with concurrence of the deputy administrator of NASA, announced on 7 April 1973 the decision that the Papago Indian Reservation will be the operational site.

C.1.4 Design Analysis

Selection of the Papago Indian Reservation as the site permitted the design effort to proceed, and special attention was given to the following design areas:

- Communication Relay System
- Slo-Scan TV Transmission
- Special Medical Equipment
- Computer Interfaces, Software Requirements
- TV System
- Mobile Health Unit

Communication Relay System. A detailed communication analysis was conducted, which included a survey of communication equipment manufacturers, particularly those engaged in producing microwave TV equipment, multiplex voice/data microwave systems, and vhf radio equipment. A signal strength measurement type radio survey was conducted at the site. Various mountain ranges were investigated and radio communication links established between Quijotoa and potential Mobile Health Unit stops. Results of the communication investigations were as follows:

- Selection of Quijotoa Relay Station to interconnect the HSSCC, LHSC, and MHU
- Selection of 7.5- and 1.8-GHz (approximated bands) for TV and multiplex transmission, respectively
- Provision of vhf radio for backup
- Space for radio controller to communicate with the ambulance vhf network

Slo-Scan TV Transmission. A requirement of the STARPAHC program was to provide communication between the physician at the Sells Hospital and specialists at the Phoenix Indian Medical Center (PIMC). To be of any benefit, voice and visual data must be transmitted. Investigations showed that transmission of video and voice via microwave would involve repeaters on Quijotoa and Slate Mountains, and receiving and transmitting equipment on South Mountain in Phoenix. The cost of the additional equipment considerably exceeded the program budget in this area, so other transmission techniques were evaluated.

The Slo-Scan TV technique of recording visual data and retransmitting to a receiving/recording unit and subsequently displaying the visual information is developed. Of interest was the quality of the transmission, particularly x-rays, the acceptance of the data by qualified medical personnel, and the diagnostic value. A functional demonstration was developed to install improved two-track Slo-Scan equipment in Sells Hospital and in the PIMC, interconnected via C2 conditioned telephone lines. Medical personnel were used at each terminal to establish the quality of the transmitted information. Teaching-type x-ray images were used at the transmission end, and independent diagnoses were made at the terminal end by PIMC medical personnel. Results of the test indicated that by using the two-track system, C2 conditioned telephone lines and proper camera techniques, acceptable images were transferred. Accordingly, this technique was recommended for the STARPAHC Program.

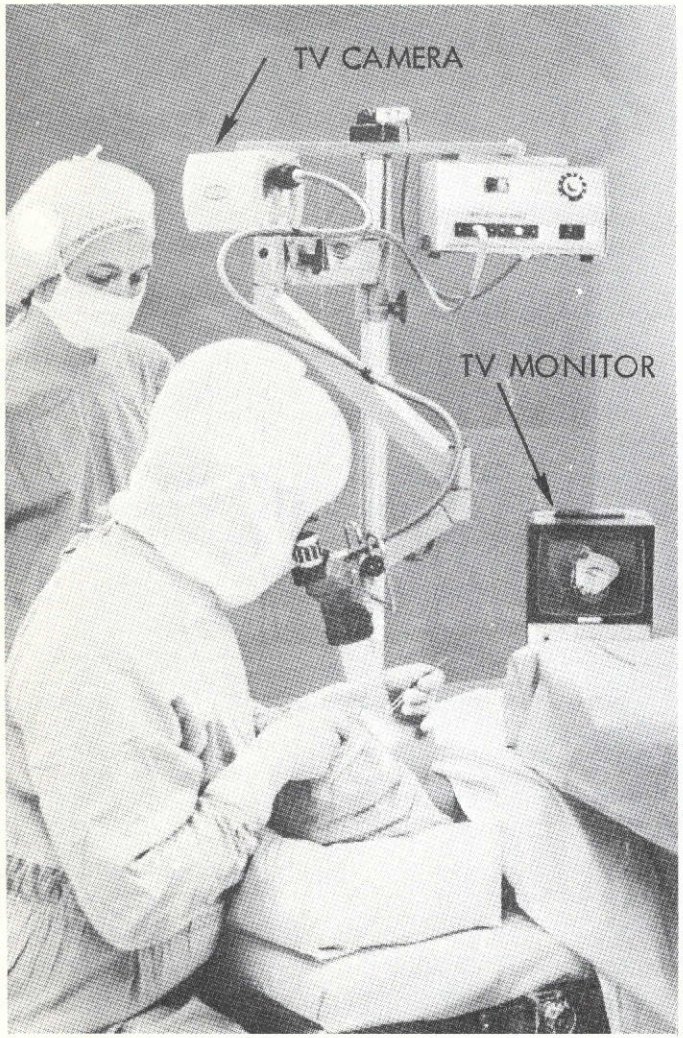
Special Medical Equipment. Of interest in the selection of special medical equipment were instruments that could take maximum advantage of the various communication media and provide sufficient information to a remotely located physician to support a diagnosis or recommendation as to further action by health care professionals. The following items met these requirements:

- Patient Viewing Microscope With TV
- TV/Microscope
- Electronic Stethoscope
- X-ray Viewer With TV
- ECG Monitor

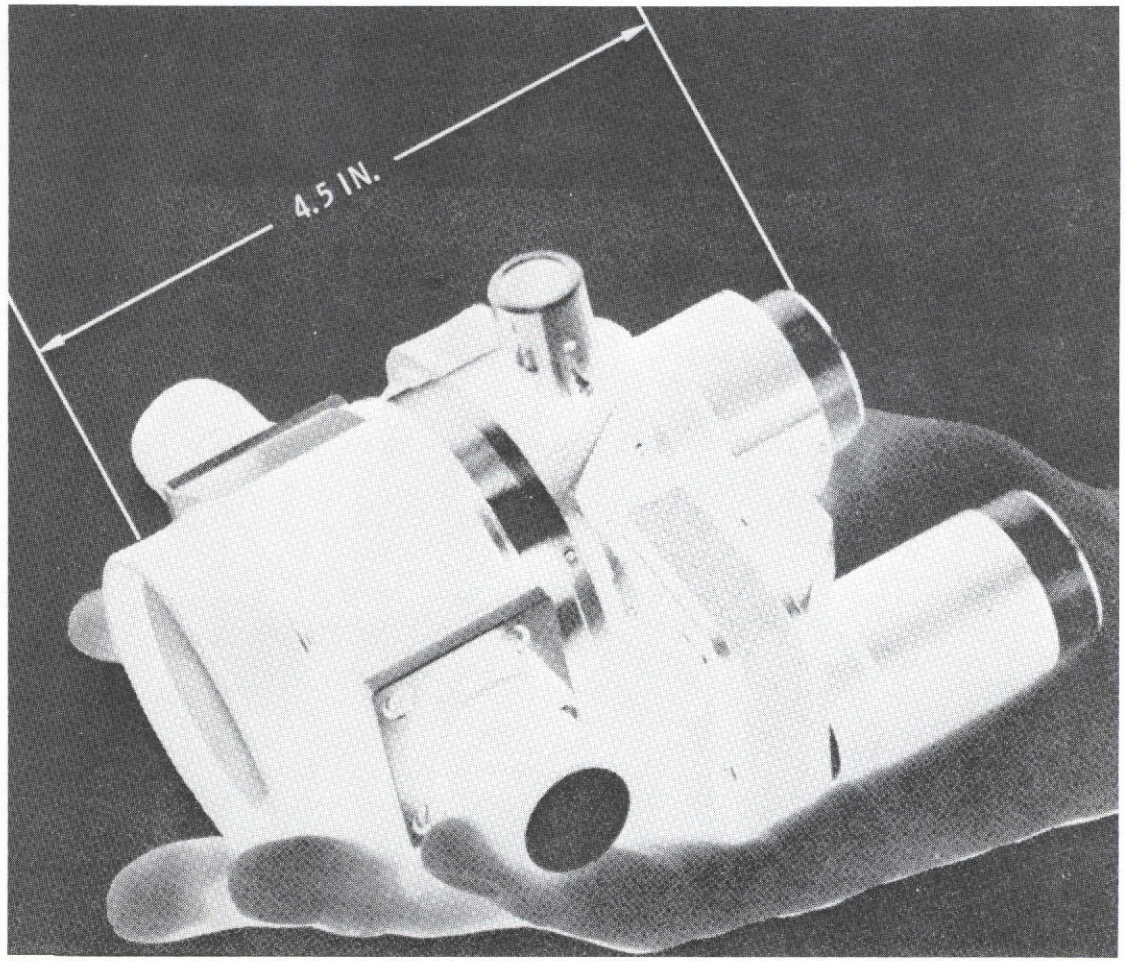
The patient-viewing microscope adapts an existing (fiber optics/TV transmitting) surgical viewing microscopic technique and uses it to enable endoscopic-type examinations of areas such as eyes, ears, nose, throat, and rectum (Fig. 4). The TV microscope (trinocular) permits TV transmission of microscopic slide data. The electronic stethoscope permits monitoring of heart sounds and transmission of that information to the physician. The x-ray viewer, used in conjunction with a B&W TV camera, and special techniques developed by NASA permits transmission of x-ray images by real-time Slow-Scan TV. The ECG monitor detects and transmits, (via the communication system), ECG data that can be viewed on a cardioscope and on a strip chart recorder at the HSSCC.

General Medical Equipment. To facilitate the performance of a CHM under physician direction and to provide a capability for a more thorough laboratory work-up in the field, additional general medical equipment was required. This equipment included additional examination equipment such as an Otoscope/Ophthalmoscope-Diagnotic Set, a Tonometer, and various Specula; emergency treatment/stabilization equipment; a portable infant incubator; and various laboratory specimen preparation and measurement instruments.

Computer Interfaces and Software Requirements. The existing IHS computer, with its medical history data base on the Papago Indians, interfaces with the LMSC-provided minicomputer and its NASA-provided MEDICS II generalized information storage and retrieval system. MEDICS II is an enhancement of the existing MEDICS system now in use at NASA/JSC, with certain special features added to support specific STARPAHC requirements. Modifications to MEDICS will be implemented by Philco Houston Operations (PHO) under direction of the Flight Operations Directorate (FOD) at NASA/JSC. An interface document describing in detail the necessary modifications to MEDICS to produce MEDICS II will be prepared jointly by LMSC and PHO and approved by NASA before any software implementation begins.



PATIENT VIEWING MICROSCOPE AS USED UNDER SURGICAL OPERATING CONDITIONS



MICROSCOPE

Fig. 4 Patient Viewing Microscope

LMSC will implement all STARPAHC applications including a HIS data concentration function which permits access to the HIS data base via the LMSC-provided minicomputer. The application programs are organized into the following five end-items:

- HIS Data Concentrator
- Interim Medical Data Storage
- Paramedic Aids
- Inpatient Aids
- Administrative Aids

TV System. Requirements exist for the physician to view the patient and for transmitting the physician's image to patients at the clinic or Mobile Health Unit. Additional requirements exist for transmitting and receiving microscopic data and for transmitting and receiving other visual data. The TV system that evolved from the design analysis incorporated remotely controlled pan/tilt/zoom capabilities for those cameras that view patients and x-rays. Color TV with its broader capability for medical interpretation was recommended for viewing patients, while B&W TV, with its inherently better resolution, was selected for x-ray image transmissions. TV monitors are required for viewing the transmitted data as well as for monitoring the quality of the transmitted data at the source.

Mobile Health Unit. The basic requirement of the mobile health unit is that it parallels the fixed-clinic functions as closely as possible. The major design problem was to incorporate these functions (examination, treatment, reception, laboratory, and x-ray) in an area approximately 5 percent of that of a fixed clinic. Various design configurations were studied and a full-scale soft mockup was constructed to assist in finalizing the design.

C.1.5 Design Configuration

The following sections describe the hardware and software of STARPAHC. Major STARPAHC elements are as follows:

- Sells Hospital [Health Services Support Control Center (HSSCC)]
- Santa Rosa Health Center [Local Health Services Center (LHSC)]

- Mobile Health Unit (MHU)
- Phoenix Referral Center (PRC) in the Phoenix Indian Medical Center
- Tucson Computer Center (interface only)
- Relay Station (Quijotoa Mountain Range)

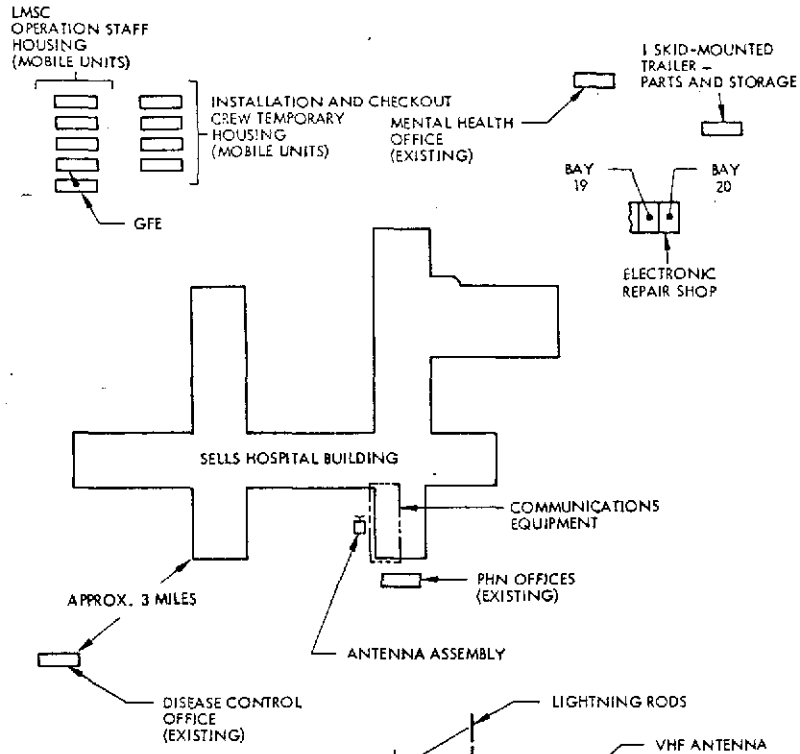
Their requirements and characteristics are summarized in the following paragraphs.

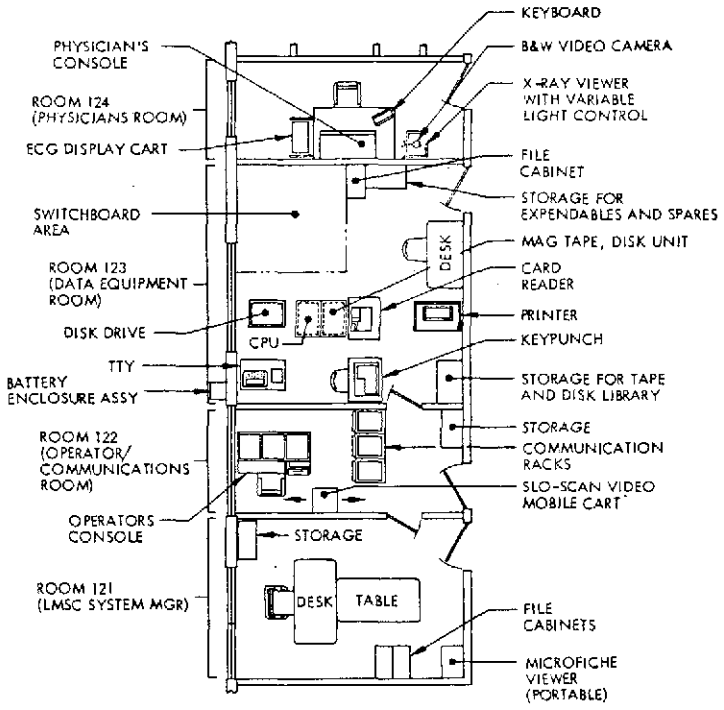
Health Services Support Control Center. Health consultation with and direction to Community Health Medics (CHMs) at the Santa Rosa Health Center and in the MHU impose the following functional and design requirements on the HSSCC:

- Voice communication between the physician at the Sells Hospital, the Sells STARPAHC operator, and all health care elements of STARPAHC, as well as the existing ambulance van radio network
- Video communication between physician at the Sells Hospital and all health care elements of STARPAHC, including transmitting visual data to the PRC
- Minicomputer services for data terminals and interface with the Health Information System (HIS) Computer

The HSSCC will be located in four rooms of the Sells Hospital (Fig. 5). A physician's console will be located in one of the Sells Hospital rooms. Medical display and recording equipment mounted on a portable cart will be provided for the physician to view ECG data (two-channel cardioscope) transmitted from the LHSC and/or the MHU and for recording the ECG data on a three-channel strip chart recorder for permanent records. A headset and gain control for electronic stethoscope signals will be installed in the physician's console.

Radio equipment (vhf/uhf and microwave); an audio recorder for recording voice, ECG, and heart-sound data; and a video recorder will be located in another room along with the operator's console. Computer equipment and supporting peripherals will be located in a third room along with the existing telephone switchboard. The microwave communications system at the HSSCC provides the physicians at HSSCC direct voice and visual contact with health-care professionals in remote facilities and immediate





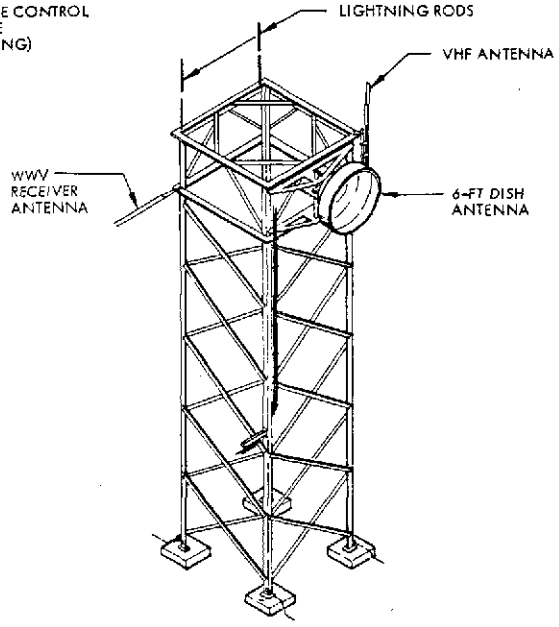


Fig. 5 Health Services Support Control Center

access to desired test data or measurements. Color and black and white (525-line) television are provided for use by the physicians. A separate vhf radio is provided as a backup. A Slo-Scan video link (operating on C2 conditioned telephone lines if necessary) is provided between the HSSCC and the PRC. This permits consultation between the HSSCC physician and specialized medical personnel at PRC. Conditioned dedicated C2 telephone service is used for the high-speed digital data (4800 baud) link transfer between HSSCC and the Tucson Computer Center. The centralized minicomputer at the HSSCC functions with a larger remote computer system. The STARPAHC computer supports up to 15 remote terminals.

Medical summaries entered into the STARPAHC system by field personnel at the LHSC or the MHU are temporarily stored in the STARPAHC computer and will be available for display at any CRT or TTY terminal within the system. These data will be prepared for entry into the HIS data base via a centralized data entry facility located at San Xavier. This facility will be staffed by and will be the responsibility of IHS personnel. After verification that these data are entered into the permanent HIS data base, they will be purged from the STARPAHC memory to release space for future entries. This technique permits rapid input and retrieval of patient medical data during the interim handling period. Plans exist for moving the key-to-tape preparation of written medical history used for HIS data base up-date to the HSSCC and relaying the taped record to the HIS computer via its interface with the HSSCC computer.

Maintenance and calibration equipment will be located in two of the Sells Hospital garage bays adjacent to the existing maintenance shops. Five housing trailers will be installed on prepared sites outside the Sells Hospital to accommodate the LMSC staff. A four-wheel drive vehicle (GFE) will be used for facility servicing by the system technician.

Local Health Service Center. Patient identification, history retrieval, physical examination, and medical diagnosis carried out at the Santa Rosa Health Center impose the following major functional and design requirements on the LHSC:

- Selected medical equipment to improve the health care capability at LHSC
- Voice, data, and video communication between the LHSC CHM and the HSSCC physician

- Terminal/display access to the STARPAHC and HIS computer for temporary entry of health care data, retrieval of data, and display of patient's health records for review and/or update

The LHSC will be located in the existing 4800 ft^2 Santa Rosa Health Center (Fig. 6). The LHSC will function 8 hours a day, 5 days a week, with a 24-hr on-call capability.

Patient medical data will be entered by a staff member through a data entry terminal. Entry format will be in clear text (English language) for temporary storage at the HSSCC. Processed x-ray films will be viewed at the HSSCC via B&W TV and the films themselves forwarded to the HSSCC at the first available opportunity for storage. Communications and data management equipment will be installed in a small room, being added to the Santa Rosa Health Center. A 208 Vac, 60 Hz, 3 Phase, 55 kW emergency generator system will be located adjacent to the LHSC.

Requirements for special medical equipment were met by providing an electronic stethoscope, an ECG recorder to interface with the communication system, a trinocular microscope for simultaneous viewing of the microscope field by the CHM at the LHSC and transmission of the slide image to the physicians at the HSSCC, a variable illuminated x-ray viewer for TV interface, and a patient viewing microscope to translate endoscopic-type examinations to TV for relay to the HSSCC. An automatic x-ray processor is provided to reduce processing time at the LHSC.

Requirements for communication and data management are met by providing alphanumeric data terminals for the clear-text entry of medical history data for STARPAHC temporary storage, retrieval of STARPAHC or HIS medical records and CHM standards-of-care data, patient scheduling information, and other administrative functions. Audio-visual communication between examination, treatment, and laboratory rooms of the LHSC and the HSSCC, together with private communication (audio) between the LHSC CHM and the HSSCC physician provide the discretion and control required by the responsible physician. An operational console provides for the CHM's interface with the system.

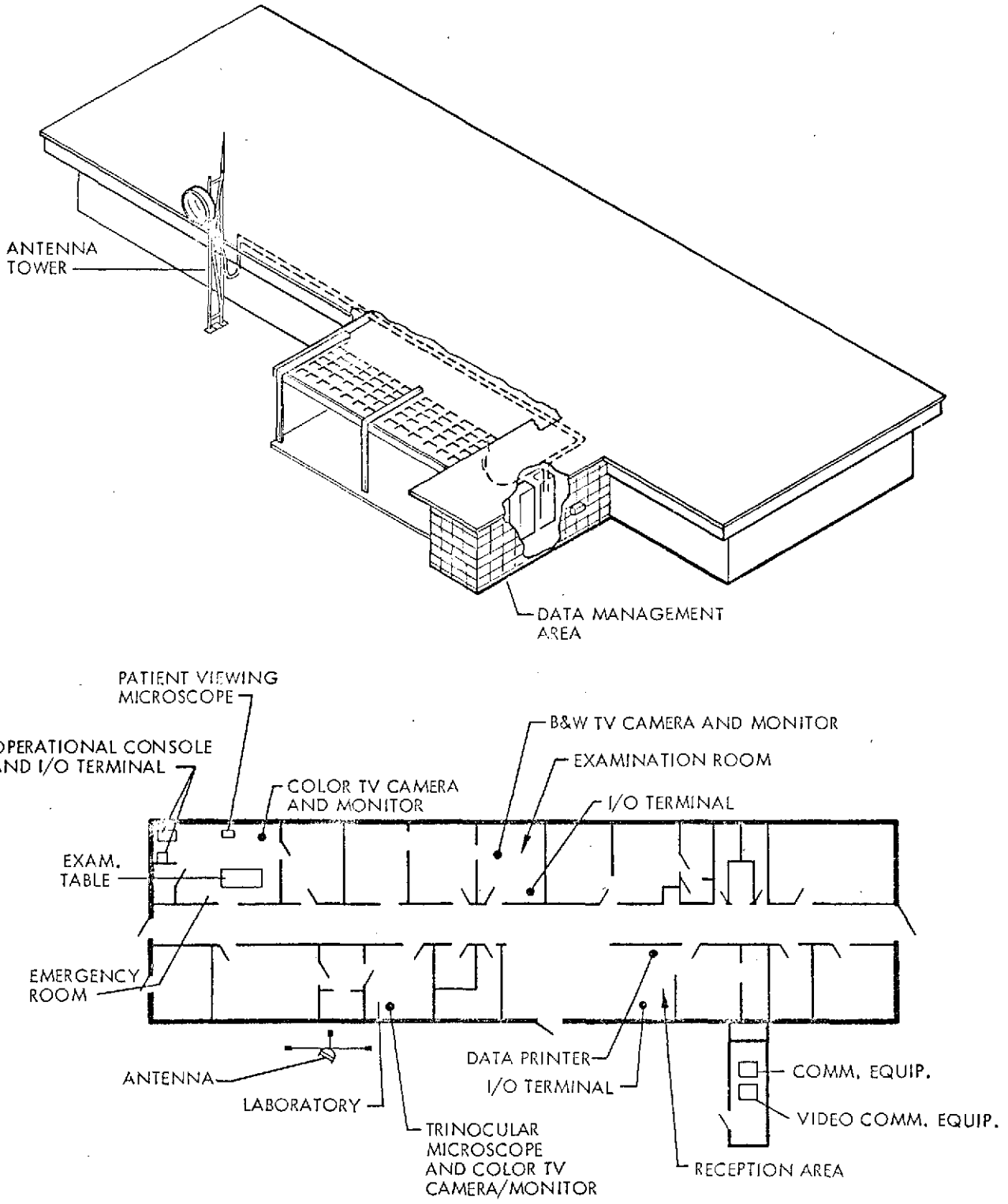


Fig. 6 Local Health Services Center

LHSC communicates information by the following means to the HSSCC – private voice, ECG and electronic stethoscope signals, low-speed digital data, camera control (from the HSSCC), and two-way television. The LHSC has a common-voice vhf transceiver similar to a transceiver/repeater located at the relay station. Common-calling channel communication is possible for the LHSC with any other unit within range (radio line of sight) of the relay station.

Mobile Health Unit. The MHU provides health care functions identical to those of the LHSC, although limited as to patient load and available volume. The medical and operational functions impose the following major functional design requirements:

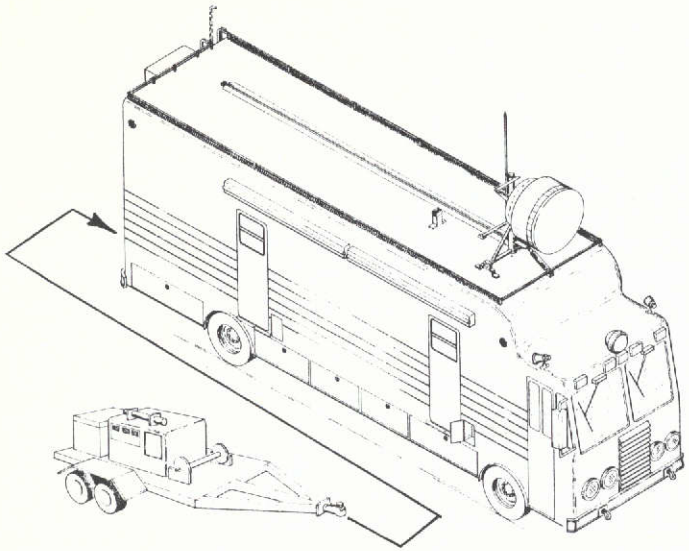
- Provision of selected medical equipment
- Voice, data, and video communication between the MHU CHM and the HSSCC physician
- Terminal/display access to the STARPAHC and HIS computers for temporary entry of health care data, retrieval of data, and display of patient's health records for review and/or update

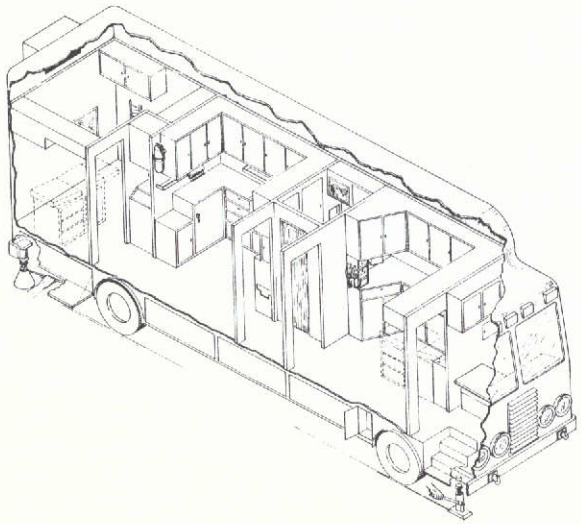
A completely equipped, self-propelled mobile vehicle and a trailered power unit will be provided. Interior dimensions of the van will be (Fig. 7):

- Interior Length: 29 ft
- Interior Width: 7 ft 6 in.
- Interior Floor to Ceiling Height: 7 ft 6 in.

The MHU will have a 120/240 Vac, single phase, 60 Hz, 4-wire electrical system. Air conditioning/interior heating will be provided to maintain required environmental conditions inside the unit with exterior temperature at an ambient maximum of 110°F and a minimum of 30°F. Normal internal operating temperature will range between 70° and 80°F.

The MHU generally will operate 6 hr/day, 5 days a week (2 hr/day may be allocated to driving to/from scheduled stops). The schedule and routes will be determined by the IHS. An adequately shielded x-ray room is included, containing an x-ray unit, developing tank, and associated x-ray drying and viewing equipment. The floor plan also





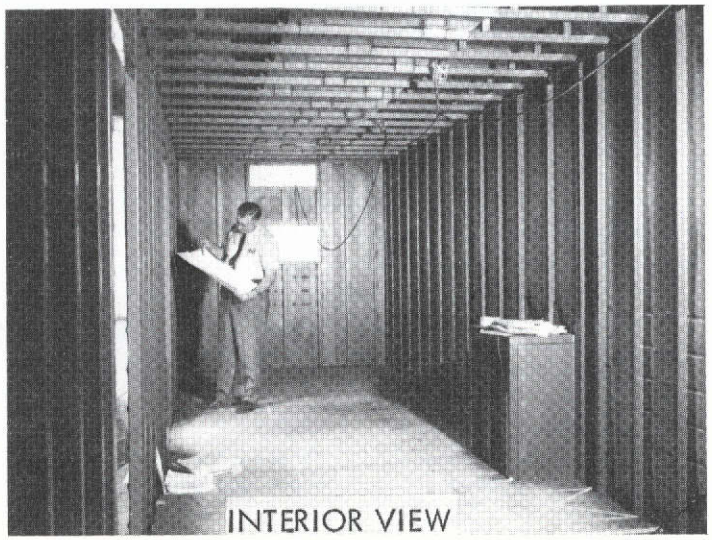


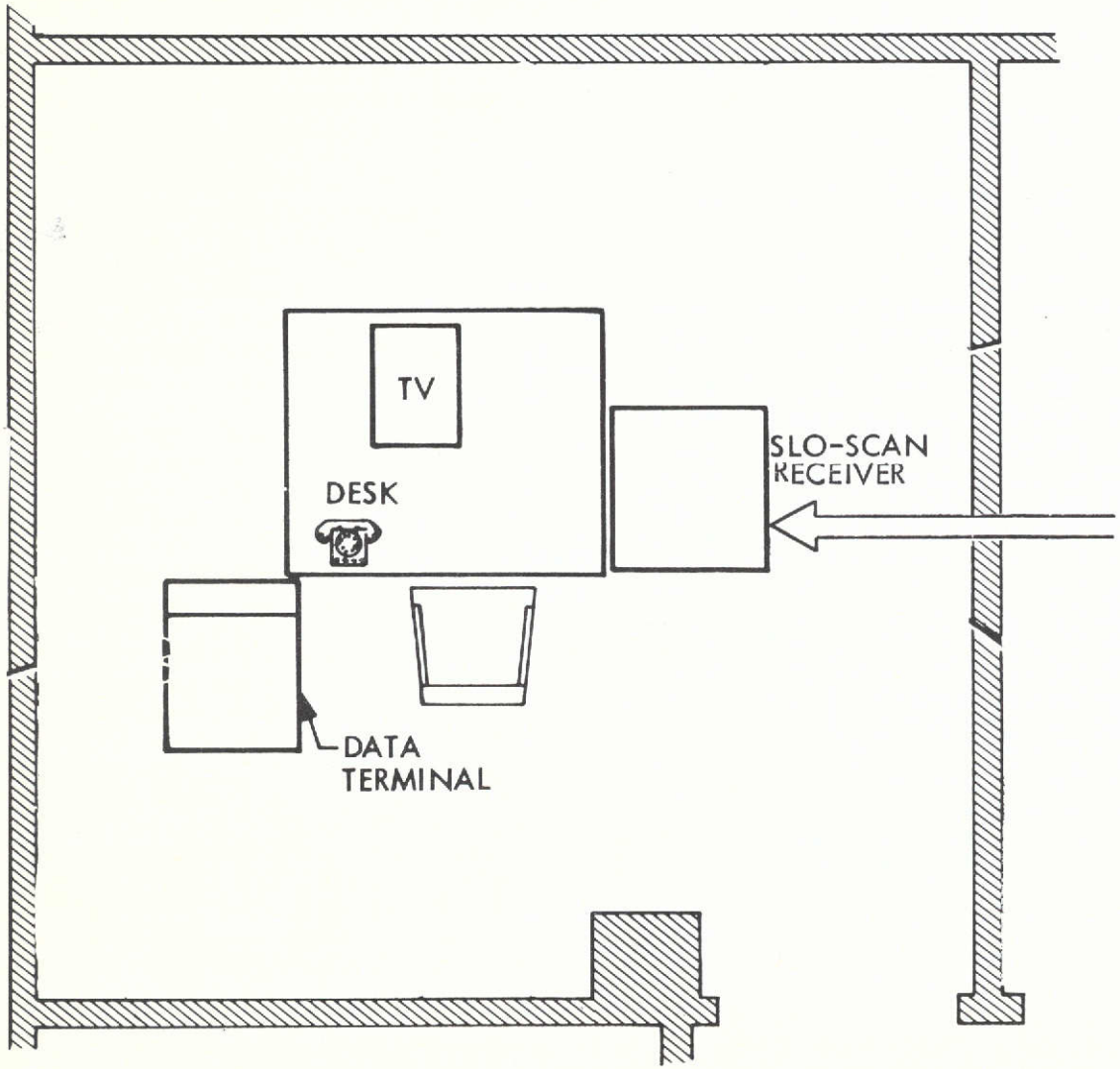
Fig. 7 Mobile Health Unit

includes an examination/treatment room; a lavatory; and reception, communication, and laboratory areas. A freshwater container, hot-water heater, and waste tank are provided. The MHU will have a roof-mounted microwave dish, with vertical (5 deg) and azimuth (350 deg) adjustments, that can be stowed during transit and erected easily at each stop. A whip-type vhf antenna and suitable lightning rod will also be mounted on the roof. Emergency egress will be provided in addition to the normal entrance/exit door.

Special and general medical equipment identical to that used in the LHSC is provided in the MHU, with the exception of a manual x-ray developer in the MHU, which was more adaptable to the mobile environment than the automatic unit in the LHSC. Microfiche viewing equipment will be provided for medical references. Counter space of 18 by 36 in. and power outlets will also be provided in the MHU for NASA-JSC advanced bio-instrumentation. Typical instruments to be field-evaluated are the zero-gravity analyzer, blood-pressure monitor, cell counter, and slide stainer.

The MHU communication system provides audio, visual, and data contact between the MHU and the HSSCC. The terminal communication equipment includes all consoles, control and display items, and antennas required in the MHU. A silent teleprinter provides for health data retrieval, and operational or health data entry. Three color cameras (with two small wall-mounted color monitors for field-of-view verification or physicians image display) provide for transmitting patient images (normal or microscopic) from the examination-treatment room to the HSSCC, or microscopic data from the laboratory. A separate B&W TV camera with viewing monitor is provided for x-ray transmission.

Phoenix Referral Center. STARPAHC supports IHS-provided medical specialist consultation with the physician at Sells by telephone interconnections between STARPAHC health personnel and the PIMC specialist that will accommodate verbal exchanges and visual data transmitted from the HSSCC to the PRC via Slo-Scan TV. The health specialist at the PRC has access to the HIS data base and can participate in conference calls between HSSCC, LHSC, and MHU (Fig. 8).



RECEIVER

Fig. 8 Phoenix Referral Center

Tucson Computer Center. The STARPAHC Program computer, located at the HSSCC in Sells, interfaces with the HIS in the Tucson Computer Center. The function of the HIS in support of STARPAHC is to provide HIS data (on-line medical retrievals of patient data) to all CRT and TTY terminals within the system. HIS data requests are routed to the HIS computer, which responds to the requesting terminal.

The HIS medical data base contained within the Tucson Computer Center will not be duplicated within the STARPAHC computer. IHS will make available medical data retrievals and reports from this data base; however, data entered into the data base and retrieval data content and format will be controlled by IHS.

A conditioned dedicated C2 telephone line is provided by the IHS for transfer of high-speed serial-digital data between the HSSCC computer and the Tucson Computer Center.

Relay Station. Functionally, the Relay Station will provide unmanned microwave (narrow and wide band) interconnecting links for full duplex voice and television communication between the physicians, operators, and Community Health Medics associated with STARPAHC. An additional vhf half-duplex voice system will provide enroute communications with the Mobile Health Unit and/or a backup voice net for the microwave links.

The site will be prepared to accept an antenna tower at the site's highest point, a portable building immediately southwest (downhill) of the antenna tower, and a 50-ft terminal pole approximately 10 ft southwest of the portable building (Fig. 9).

Preparation of the site will include installation and connection of input power to the portable building from the LPG generator power source. The terminal pole nearest to the portable building (50 ft high) will be topped with a lightning rod. A vhf radio antenna will be mounted on the northeast side of the terminal pole. A 6-ft fence topped with barbed wire will be installed around the Relay Station. A gate will be installed in the fence where it crosses the access road to the Relay Station site.

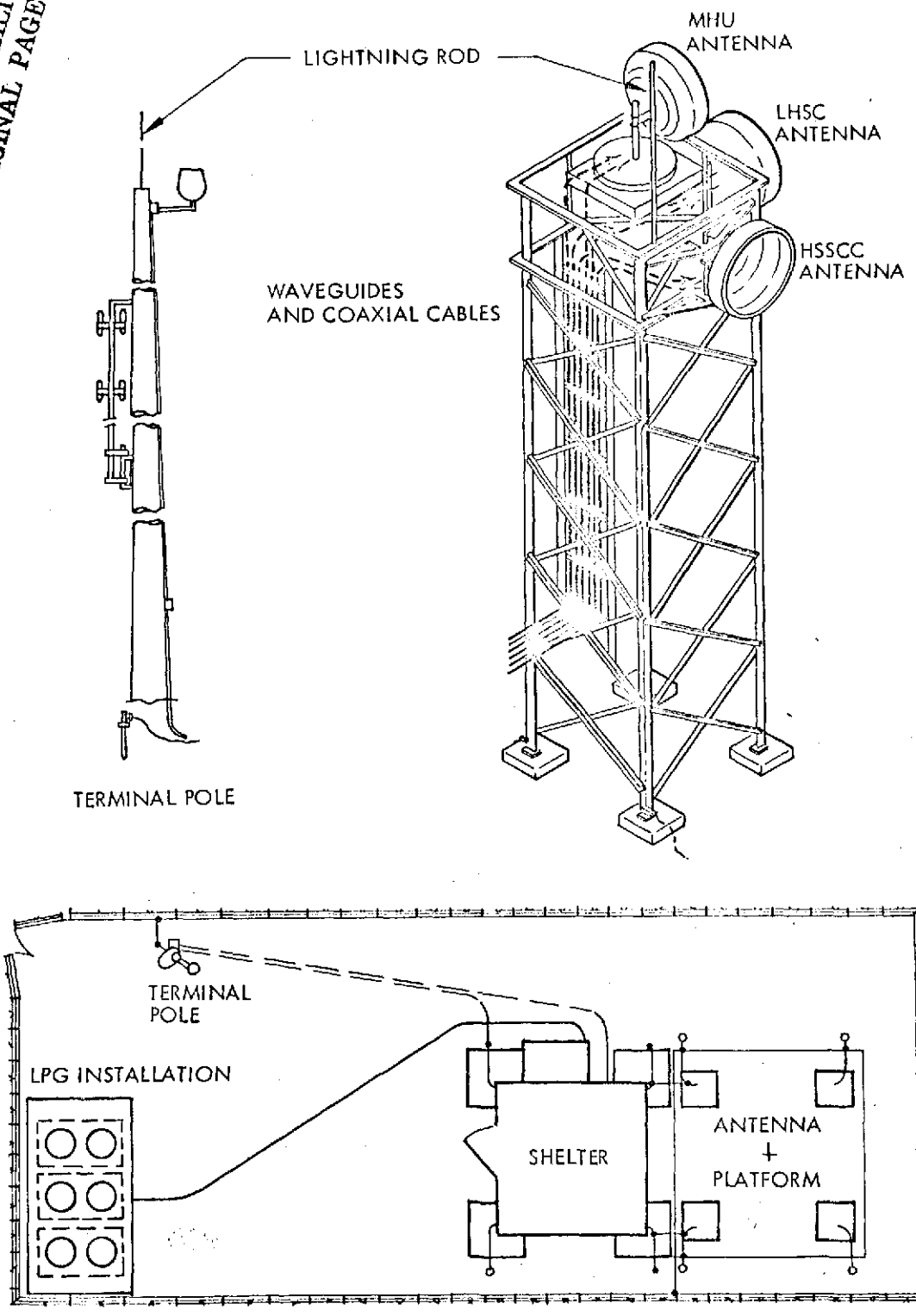


Fig. 9 Site Layout — Quijotoa Relay Station

The site will include installation of two 2.5-kW generators on the building platform and facilities for an LPG storage tank in the vicinity of the generators. One generator will serve as the primary power source and the other will be backup. Batteries will support equipment operation for up to 6 hours in the event of both generators malfunctioning.

The portable building is provided to house rack-mounted microwave and vhf equipment and the batteries, and is fully insulated and equipped with an air conditioner for environmental control.

C.2 BUDGETARY HISTORY

The original STARPAHC program negotiated cost was $4,942,079, covering a 4-year period. A baseline system formed the basis for the cost and included:

- HSSCC (1)
- LHSC (1)
- MHU (1)
- Relay Station (1)
- Dispensary Ambulance (1)
- Ambulance with Portable Examination and Portable Ambulance Modules (1)
- System and medical operations for a 2-year period

Recosting of Part 2 (Assembly, Test, Installation, Checkout, and Tracking) and Part 3 (Operations, after site selection) was a contract requirement since it was known that the actual site would affect the negotiated cost.

After site selection (13 April 1974) LMSC was directed by NASA to evaluate (1) the cost resulting from site selection and (2) the impact of various options. The evaluation options included various combinations of NASA/DHEW participation and a scaled-down design concept. The cost of the resulting modified system (described under section C.1.5) to NASA is $3,352,000, and DHEW/IHS participation is estimated in excess of $900,000. The DHEW/IHS participation occurs in (1) providing onsite facilities and leasing vans, trailers, and data phone links, (2) providing expendable medical equipment and medical supplies during the 2 years of operation (3) providing medical support personnel in the field, and (4) evaluating the medical operation.

Part 1 (Definition and Design) major layout design drawings were completed on schedule and slightly under the planned budget. Figure 10 shows the expenditures versus time. Part 1 budget was $789,809, while actual expenditure was $785,566.

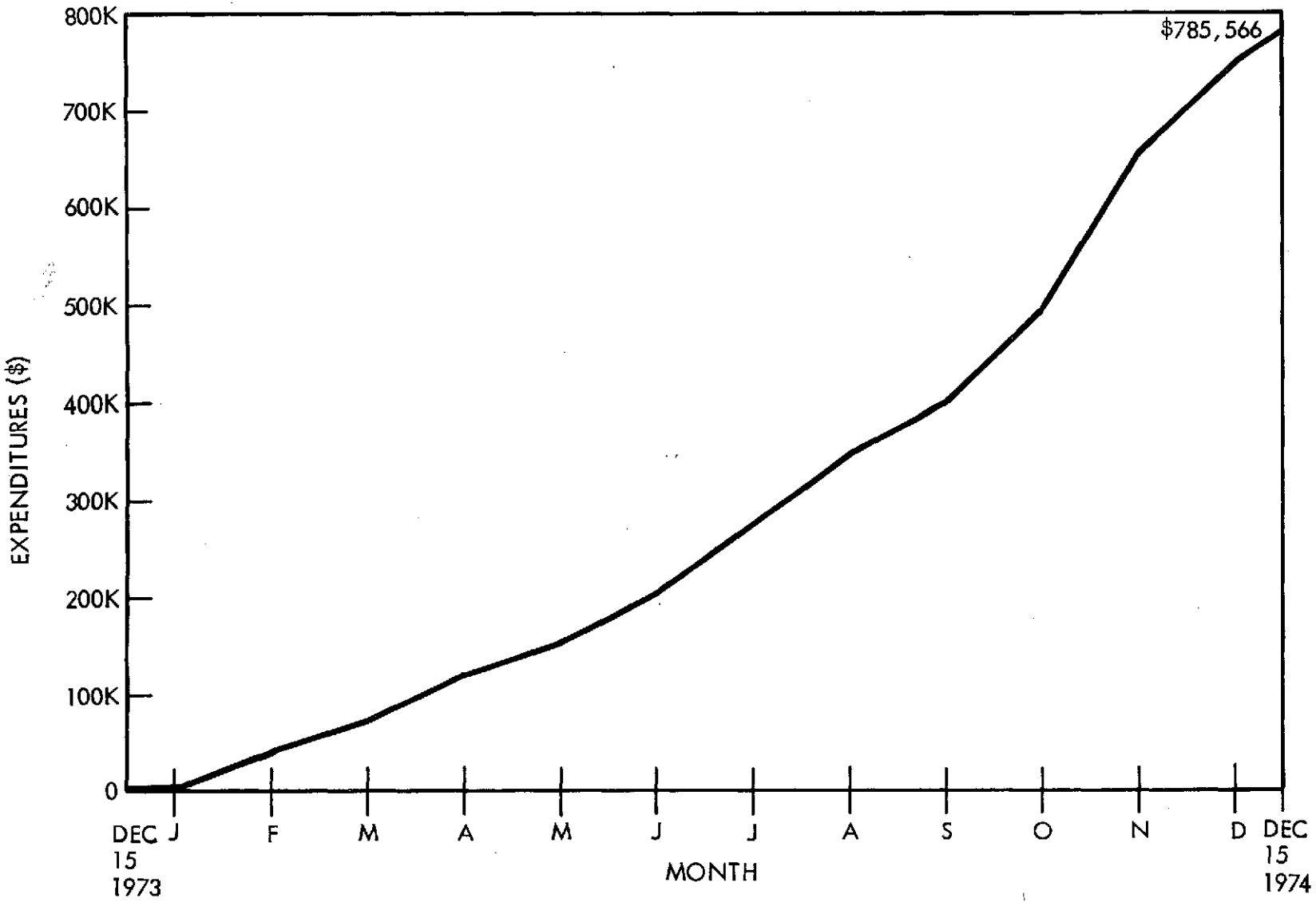


Fig. 10 Part 1 Expenditures

Section D

CONTINUED PROGRESS

D.1 PART 2 – ASSEMBLY, TEST, INSTALLATION, CHECKOUT, AND TRAINING

Part 2 effort was initiated 1 August 1973, with the identification of long-lead procurement items, preparation of a procurement plan, and manufacturing preplanning. The Varian computer was ordered on 1 August 1973. It was necessary, also, to place an order for the MHU chassis and modification to the chassis, which included lengthening and addition of an automatic transmission. Terracom TV transmitter/receivers were ordered early (1 November 1973) to meet schedule dates. The remaining equipment and subcontractors were scheduled for procurement and signup in January 1974. The schedule shown on Fig. 11 highlights some of the more important milestones. Manufacturing startup was scheduled upon completion of design release. Detailed Assembly Sequence Charts will be prepared. Subassembly work will be completed early in July at which time system assembly and integration will be initiated, which consists of completing console assemblies and communication racks, and checking out the equipment. This will be followed by initial acceptance tests at LMSC for manufactured equipment. LMSC Acceptance tests for communication equipment, computer, and modified TV equipment will occur at the vendor's plants. The Mobile Health Unit will be acceptance tested initially at the Medical Coaches, Oneonta, N.Y., Final acceptance will be accomplished at the site.

Installation and checkout at the operational site are scheduled to begin 1 Aug 1974. Prior to this date, facility preparation work will be completed consisting of general construction work.

Planning for the training activity started early in Part 2. Responsibility guidelines provided for IHS to conduct medical training and LMSC to conduct system training. Operation and maintenance manuals and training manuals will be developed by LMSC.

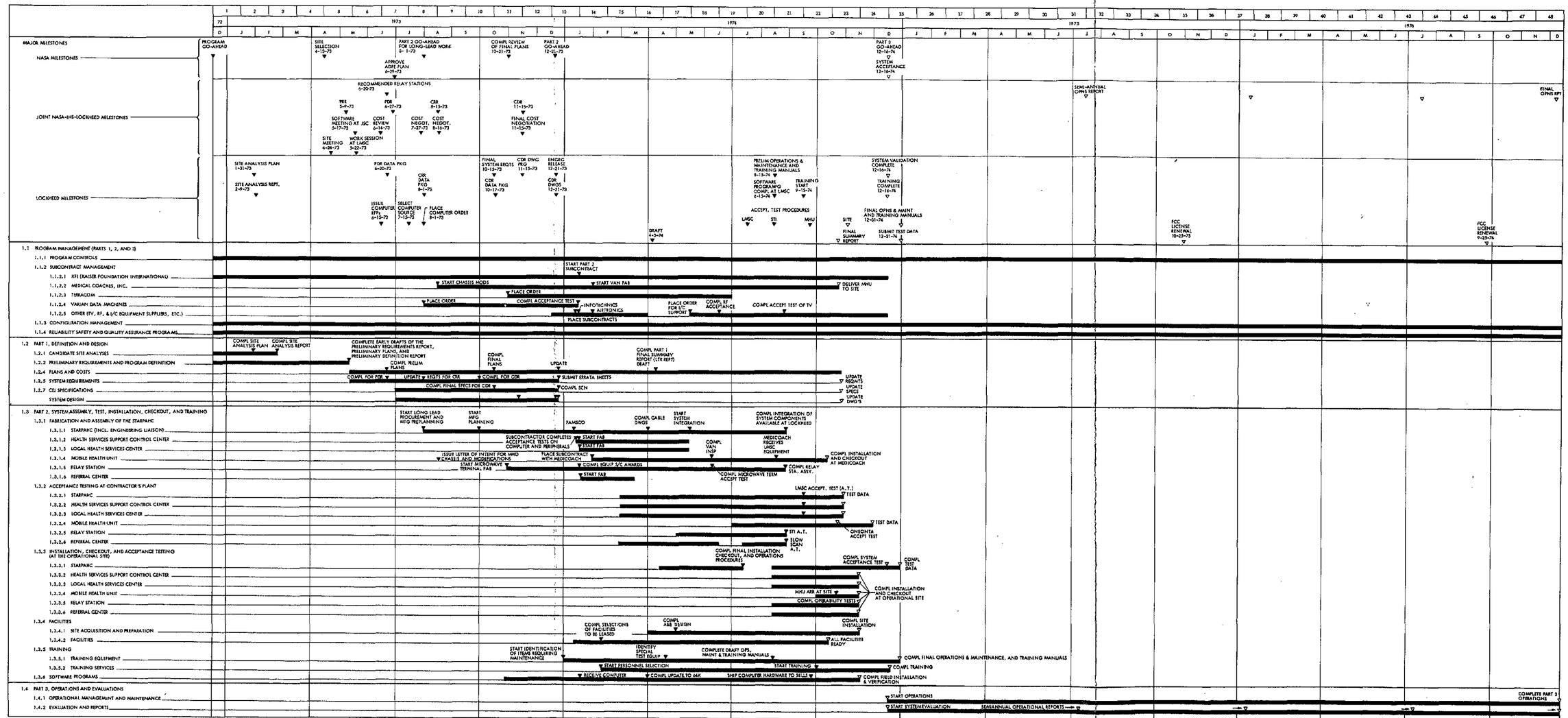


Fig. 11 Program Schedule

The software program development schedule is shown in Fig. 11. LMSC will implement all STARPAHC applications with five software programs.

D.2 COST PLAN

The Contract Work Breakdown Structure (WBS) established for Part 1 will also apply to Part 2, with the necessary additions to identify specific work tasks of Part 2. LMSC expenditures are monitored on a weekly basis and a computer summary tape issued. This is reported to NASA weekly with a monthly summary issued as part of the monthly progress report. Figure 12 shows the planned expenditures of Part 2 funding. The following table summarizes incremental costs that LMSC projects for the total program:

FY 1973	$ 287,267
FY 1974	1,509,667
FY 1975	1,152,696
FY 1976	263,898
FY 1977	138,472
	$3,352,000

D.3 POTENTIAL PROBLEMS AND REMEDIAL PLANS

Potential problems involved in a program as complex as STARPAHC are usually associated with the multiplicity of integration details. Integration levels exist among NASA, IHS, and LMSC, between LMSC and subcontractors, and among LMSC engineering, manufacturing, and tests.

Logic flow diagrams have been prepared that offer a trackable control method. Duplicates of these diagrams were provided to NASA and to IHS, so that action items could receive attention at their responsible location. The flow diagrams depict action items such as start and completion milestones for important events.

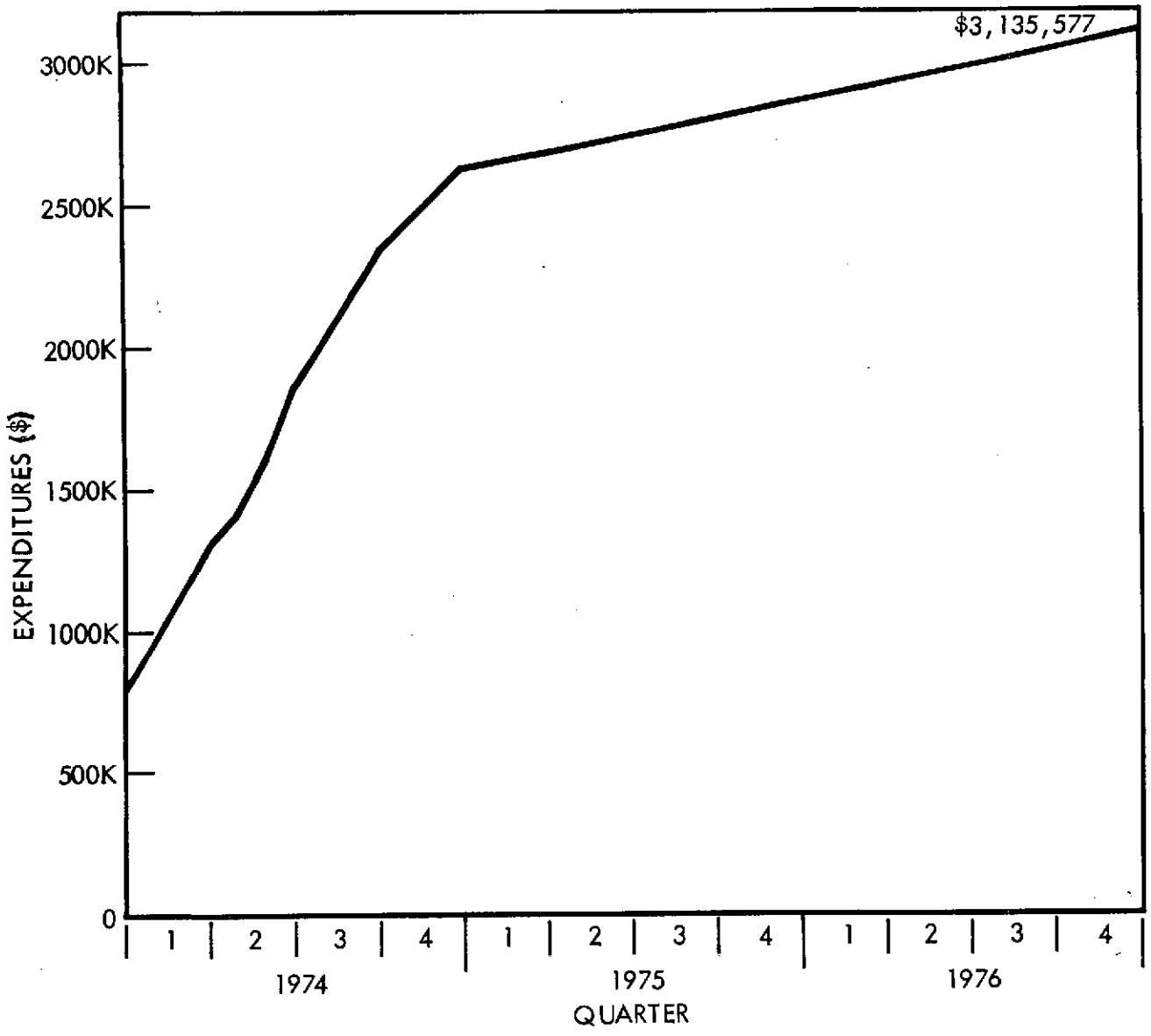


Fig. 12 Parts 2 and 3 – Planned Expenditure

In the test area, four test categories were established to ensure that the final product could enter Acceptance Testing with a high probability of passing. These tests are designated:

- Functional. All commercial equipment will be subjected to this test to verify its operability upon receipt by LMSC.
- In-Process. As equipment and components undergo assembly into subassemblies and racks, they will be subjected to intermediate in-process tests to verify correct interfacing, compatibility, and proper operation.
- LMSC Assembly Acceptance Test. Each assembly of the HSSCC, LHSC, MHU, PRC, and Quijotoa Relay Station will be subjected to an acceptance test to verify overall correct operation in all functions. In some cases, these tests will be accomplished at subcontractor locations and will conform to their standard commercial practices.
- Site Acceptance Test. After STARPAHC is installed and checked out, a final site acceptance test will be performed.

D.4 PART 3 – OPERATIONS AND EVALUATION

Operation and evaluation of the STARPAHC Program will be the joint responsibility of IHS in the medical operations and LMSC in the system operation.

Medical operational support will be provided by IHS in the form of physician support at the Sells Hospital to monitor IHS paramedical personnel working in the LHSC and MHU. Specialist support will be available at the PRC. All medical consumables, drugs, and pharmaceuticals, and spare and repair parts for IHS-provided equipment will be the responsibility of IHS.

LMSC operational personnel consisting of a System Manager, two System Operator/Maintenance Technicians, and a Maintenance Technician will operate and service the hardware elements of the system and provide administrative support, logistics, and coordination with IHS personnel as required for system operation.

LMSC will be responsible for system management, including logistic support, maintenance, calibration, and repair for equipment items specified on the Engineering Parts List.

The organizational relationships within and among participating elements involved in the operation phase are depicted in Fig. 3. On a day-to-day operating level, continued interfacing among IHS, NASA, and LMSC will be required. The monthly list of current action items will define responsibilities and commitments of the participants as an on-going process.

Evaluation of the 2-year operation is divided between HEW (responsible for the medical operations) and LMSC (responsible for evaluation of the system hardware/software); semiannual operational progress reviews will be held and interim reports prepared.

Appendix A

PROGRAM PARTICIPANTS

	LMSC	NASA	IHS	Papago Executive Health Staff
Papago Tribe Coordination				Ralph Antone Rosemary Lopez, CHM Irene Wallace Cecil Williams
Program Controls	D. R. Bruce	R. Dittman		
Medical Direction	J. M. Lagerwerff, M.D.	S. L. Pool, M.D.	J. W. Justice, M.D. R. Leach, M.D.	
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Design Engineering	G. M. Loh P. Harper R. Luce W. C. Francis B. Hardin P. H. Szuszitzky	C. Chassay		
Communication	G. Sutton C. A. Andrews	R. Sinderson	P. Decker	
Data Processing	G. McCullough J. Ward	E. Moseley, Ph.D. M. Quinn, Ph.D.	A. E. Garratt, Ph.D.	
Reliability, QA, and Safety	A. E. Winslow K. Williamson S. Maynard	J. Shone H. Harvey D. Regan		

LMSC was supported by the following subcontractors:

Area of Contribution	Company
Medical Support	Kaiser Foundation International (KFI)
Computer	Varian Data Machines
RF Communication	Farinon, Terracom, and Structural Technology, Inc.
TV	Airtronics, Infotechnics
Mobile Health Unit	Medical Coaches, Inc.
Site Preparation	Papago Construction Co.

Appendix B
ADDITIONAL DOCUMENTATION

For more detailed information regarding STARPAHC system requirements, specifications, program definition, operations, and drawings, the reader is referred to the following documents:

LMSC/D334434	Final System Requirements Report
LMSC/D334423	CEI Specification, STARPAHC System
LMSC/D334424	CEI Specifications, HSSCC
LMSC/D334425	CEI Specifications, LHSC
LMSC/D334426	CEI Specifications, MHU
LMSC/D334427	CEI Specifications, Relay Station
LMSC/D334428	CEI Specifications, Referral Center
LMSC/D334436	Program Definition Report
LMSC/D334421	Final Operations Support Plan
C84-80	Project Document Status Report